

REMARKS

The foregoing amendment amends the specification to reflect the provisional parent application. In addition, the claims have been amended to remove the multiple dependencies.

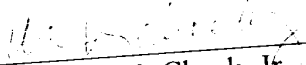
Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached pages are captioned "**Version with markings to show changes made.**"

Favorable action on the merits is solicited.

Respectfully submitted,

Koichiro NAKAMURA et al.

By


Warren M. Cheek, Jr.
Registration No. 33,367
Attorney for Applicants

WMC/dlk
Washington, D.C. 20006-1021
Telephone (202) 721-8200
Facsimile (202) 721-8250
September 27, 2001

DESCRIPTION

ADHESIVE COMPOSITION AND OPTICAL DEVICE USING THE SAME

5 Field of the Invention

The present invention relates to an adhesive composition and to an optical device constructed by bonding together optical parts by an optically transparent adhesive layer which is a cured product of the adhesive composition.

10 Prior Art

Technologies for increasing communication capacity have been becoming more and more important due to the popularization of the Internet. Bonding technologies used for the assembly of optical parts and optical elements used in these optical fiber communication systems must have high reliability and such characteristic properties as the precise adjustment of refractive index (for connecting optical paths), precise position accuracy (for bonding lenses) and high heat resistance (soldering heat resistance and heat resistance at the time of vacuum film formation). Soldering, laser welding and organic adhesives such as acrylic and epoxy resins have been used or an adhesive made from an organic-inorganic composite material prepared by a sol-gel method has been proposed to assemble optical parts. (i) A fluorinated or sulfur-containing epoxy adhesive and epoxy acrylic adhesive are proposed in Proceedings of the 48th ECTC, pp. 1178 to 1185, 1998 and (ii) an organic-inorganic adhesive prepared by a sol-gel method is described in (ii) Journal of Non-Crystalline Solids, vol. 80, pp. 557-563, 1986 and (iii) Intl. Congr. On Glass, pp. 429 to 436, 1986. An optical element using a sol-gel adhesive made from an alkoxide and a metal salt is disclosed by (iv) Japanese Patent No. 1829914 (Japanese Patent Laid-Open Publication No. 62-297369) and a prism using an adhesive made from a silicic acid salt and an alkoxide

CLAIMS

1. An adhesive composition comprising the following components:

- 5 (A) an organopolysiloxane having two alkenyl groups with 4 or less carbon atoms bonded to silicon atom in one molecule and a molecular weight of 1,000 or more;
- (B) an organohydrogenpolysiloxane having at least two hydrogen atoms bonded to silicon atom in one molecule and a molecular
- 10 weight of 1,000 or more;
- (C) a platinum-based catalyst; and
- (D) at least one selected from the group consisting of an organic silicon compound (D-1) having at least three alkenyl groups with 4 or less carbon atoms bonded to silicon atom
- 15 in one molecule and a molecular weight of less than 1,000 and an organic cyclic silicon compound (D-2) having at least three hydrogen atoms bonded to silicon atom in one molecule and a molecular weight of less than 1,200.

- 20 2. The adhesive composition of claim 1, wherein the number of hydrogen atoms contained in the component (B) and the component (D-2) is 0.4 to 6.0 times the total number of alkenyl groups contained in the component (A) and alkenyl groups contained in the component (D-1), the component (C) is
- 25 contained in an amount of 10 to 1,000 ppm based on the total weight of the components (A), (B) and (D), and the component (D) is contained in an amount of 0.1 to 40 wt% based on the total weight of the components (A) and (B).

- 30 3. ^(amended) The adhesive composition of claim 1 ~~or 2~~, wherein the component (D) is an oligomer having 3 to 8 silicon atoms.

4. ^(amended) The adhesive composition of claim 1 ~~or 2~~, wherein the component (D-1) is selected from the group consisting of

boronvinyl dimethylsiloxide, hexavinyl disiloxane,
methacryloxypropyltris(vinyl dimethylsiloxyl)silane,
octavinyl-T8-silsesquioxane,
pentavinylpentamethylcyclopentasiloxane,
5 tetraallyloxysilane, tetraallylsilane,
tetrakis(2-methacryloxyethoxy)silane,
tetrakis(vinyl dimethylsiloxyl)silane,
1,1,3,3-tetravinyl dimethyl disiloxane, tetravinylsilane,
1,3,5,7-tetravinyl-1,3,5,7-tetramethylcyclotetrasilazane,
10 1,3,5,7-tetravinyl-1,3,5,7-tetramethylcyclotetrasiloxane,
tris(vinyl dimethylsiloxyl)methylsilane,
tris(vinyl dimethylsiloxyl)phenylsilane,
trivinylchlorosilane, trivinylethoxysilane,
trivinylmethoxysilane, trivinylmethylsilane,
15 1,3,5-trivinyl-1,1,3,5,5-pentamethyltrisiloxane,
trivinylsilane,
1,3,5-trivinyl-1,3,5-trimethylcyclotrisilazane and
1,3,5-trivinyl-1,3,5-trimethylcyclotrisiloxane.

20 5. (amended) The adhesive composition of claim 1 ~~or 2~~, wherein the
component (D-2) is selected from the group consisting of
hydro-T8-silsesquioxane,
octakis(dimethylsiloxyl)-T8-silsesquioxane,
methylhydrocyclosiloxane, pentamethylcyclopentasiloxane,
25 phenylhydrocyclosiloxane,
1,3,5,7-tetramethylcyclotetrasiloxane,
1,3,5,7-tetraethylcyclotetrasiloxane and
1,3,5,7-tetraethyl-2,4,6,8-tetramethylcyclotetrasilazane

30 6. (amended) The adhesive composition of claim 1 ~~or 2~~, wherein the
component (D-1) is
1,3,5-trivinyl-1,3,5-trimethylcyclotrisiloxane or
1,3,5,7-tetravinyl-1,3,5,7-tetramethylcyclotetrasiloxane

and the component (D-2) is
1,3,5,7-tetraethylcyclotetrasiloxane or
1,3,5,7-tetramethylcyclotetrasiloxane.

5 7. The adhesive composition of claim 1, wherein the
component (A) has a viscosity of 100 to 250,000 cS at 25° C.

8. An optical device constructed by bonding optical parts
by the adhesive composition of claim 1.

10

9. The optical device of claim 8, wherein the optical parts
are optical fibers, lenses, filters, optical waveguides,
diffraction gratings or optically active elements.

✓ 10. ~~(Appended)~~ The optical device of claim 8 ~~or 9~~, wherein the optical
parts are made from glass, plastics, metals or
organic-inorganic composite materials.

11. An optical device constructed by bonding at least two
20 optically transparent optical parts by an optically
transparent adhesive layer formed by curing the adhesive
composition of claim 1, wherein the value of refractive index
of the adhesive layer was adjusted to approximate to the values
of refractive index of the at least two optically transparent
25 optical parts.

12. The optical device of claim 11, wherein when the
refractive indices of the two adjacent optical parts are
represented by n_1 and n_2 ($n_1 \geq n_2$), the adhesive layer between
30 the adjacent optical parts has a refractive index n_3
represented by the following expression (1):

$$\sqrt{(n_1 \cdot n_2)} - ((\sqrt{(n_1 \cdot n_2)} - n_2)/3) - 0.05 \leq n_3 \leq \sqrt{(n_1 \cdot n_2)} + ((n_1 - \sqrt{(n_1 \cdot n_2)})/3) + 0.05$$

... (1)